

沈阳建筑大学

毕业设计说明书

毕业设计题目 ANALYSE OF ILLUMINATION SOLUTIONS IN
CHINESE BUILDINGS BASED ON LUMINARY SYSTEMS WITH PIR AND
ULTRASONIC SENSORS

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BASED ON LUMINARY SYSTEMS WITH PIR AND ULTRASONIC
SENSORS**

Shenyang, China 2005-2006

沈阳建筑大学

(论文) 设计选题报告

信息与控制工程学院 院（系）

设计（论文）题目		中国节能照明调研			
指导教师姓名	马少华	职称	教 授	专业	电气
教研室名称	电气教研室		是否首次指导毕业设计（论文）		否
选题内容提要	This thesis focus on energy saving luminaries using PIR and Ultrasonic sensors. This final thesis is made for Ensto company.				
选题的必要性	Ensto company wanted this project and they wanted to explore illumination markets in China. Ensto company also wanted to have investigation about Chinese energy saving luminaries.				
选题的可行性	Purpose of the thesis is to help China have high quality illumination products in the future.				
审核意见	教研室主任意见		院（系）教学工作分委员会意见		
	签字： 年 月 日		签字： 年 月 日		

Time schedule of final thesis in Shenyang Jianzhu University 2005-2006

Week 46, 2005

- 1) Practical measurement arrangements
 - Install the luminary on the ceiling at the height of 2,5 m
 - o Needed for the help of researching group
 - o Need tools for installing the luminary
 - Make a PIR sensor proximity and round testing planning to laboratory room
 - Find the regulations and standards for illuminations from the books with research group
- 2) Marketing research
 - planning of marketing research (back information, discussions with research group)
 - theoretical study of the marketing research: What is marketing research? What is suitable marketing research for this case?
- 3 Meeting with research group

Week 47, 2005

- 1) Practical measurement arrangements
 - Translate the illumination regulations in China from Chinese to English
 - Making the laboratory room ready for proximity and round testing measurements
 - Decision of the content of the thesis: What will be studied and what will be left out!
- 2) Marketing research
 - Goals for marketing research together with Ensto
 - Basic data of different lighting systems and how it affects to quality of luminary
 - Start up marketing research
- 3) Meeting with research group

Week 48, 2005

- 1) Practical measurement arrangements
 - To find out how much energy saving lighting is used in China
 - In which places energy saving lighting is used
 - What are the properties needed for PIR luminaries in public buildings
 - What properties Chinese PIR luminaries have
- 2) Marketing research
 - Working hard with marketing research
- 3) PIR luminary measurements
 - PIR sensor proximity and round testing
 - Create the results of the measurements to the computer using Microsoft Excel
- 4) Meeting with the research group and professors

Week 49, 2005

- 1) Practical measurement arrangements
 - Get to know closer to Ultrasonic luminaries
- 2) Marketing research
 - Working hard with marketing research
- 3) Meeting with research group

Week 50, 2005

- 1) Practical measurement arrangements
 - Compare Ultrasonic and Infra red sensor lighting methods
- 2) Marketing research
 - Working hard with marketing research
- 3) Meeting with research group

Week 51, 2005

- 1) Practical measurement arrangements
- 2) Marketing research
 - Working hard with marketing research
- 3) Meeting with the research group and professors

Week 52, 2005

- Collect materials together for thesis
- Check of the contents with professors

Week 1, 2006

- Analyse of the marketing research and technical measurements
- Writing thesis

Week 2 – Week 6, 2006

- Writing thesis

Week 7, 2006

- Meeting with the research group and professors
- Writing thesis
- First version will be published

Week 8 – Week 9, 2006

- Writing thesis

Week 10, 2006

- Writing thesis
- Comments from the professors of the first versions

Week 11, 2006

- Writing thesis
- Conclusions and future actions presented to Ensto company

Week 12, 2006

- Presentation to professors
- Final comments from professors

Week 13, 2006

- Presentation of final thesis

Week 14, 2006

- Corrections and comments to final version of thesis

Week 15, 2006

- Presentation of final thesis
- In the beginning of week 16 everything ready

Week 16, 2006

- Death line of the study certification and sending it to Tampere Polytechnic, Finland

Week 17, 2006

- Departure from China

[illegible]

年 月 日

[illegible]

年 月 日

沈阳建筑大学

毕业设计（论文）答辩记录

____专业____班级 学生____指导教师____

毕业设计（论文）题目____

答辩时间：____年____月____日____时____分至____时____分

出 席 人

主任委员（组长）____

委 员（组员）____、____

____、____

答辩委员会（答辩小组）提出的问题和答辩情况：

Abstract

First purpose of this research project was to find out what is the level of Chinese energy saving illumination and how much energy saving illumination is used in China.

Second purpose was to buy different kinds of energy saving luminaries from China markets and find out what properties these luminaries have. We also made different tests, measurements and examined closer these luminaries.

Third and the most important purpose was to find out does Ensto have a possibility to start selling their energy saving luminaries in China. Marketing research was made for finding conclusions for Ensto. Chinese products are cheap, so it is difficult situation to fight against price for good the quality.

The result of the work was positive for Ensto, because level of Chinese energy saving illumination is not good. One luminary was tested in Jianzhu University and luminary was not good and there has many weaknesses on it. Even that luminary was the most expensive found from Shenyang, it was not working well. The sector round walking test shows the luminary is not sensitive enough and it was not working well.

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1. Goals of the research

This research project goals was find out energy saving illumination commonness in China and make marketing research of energy saving luminaries. Ensto company wants to know does they have enough recourses directing their products to China illumination markets. Selling Finnish luminaries in China also demands to know illumination standards and regulations in China.

2. Background information

2.1 Energy saving lighting

Energy saving lighting is a wide concept meaning different kinds of lighting systems saving energy. Good lighting system gives light in a right place at the right time. The lights are switched on only when it is needed. Energy saving for lighting consists of two major things: minimizing hours of need and use of installed power.

This thesis focuses on energy saving lighting using PIR and Ultrasonic luminaries in places without actual living. The best places for energy saving lighting are stairways, floors, cellars, attics, garages, bathrooms and outside of buildings.

2.2 PIR luminaries

PIR luminaries are sold about 15 years. These luminaries offer a superior solution for illumination particularly in corridors, stairways, cellars, attics, garages and bathrooms. Storerooms, attics and lobbies with a lot of irregular movement are also ideal places for PIR luminaries. The most common places for PIR luminaries are stairways in block of flats. You can only illuminate one floor or part of it. It is inefficient to illuminate an entire stairway when there is movement only on one floor.

PIR luminary is normal luminary added PIR motion detector and control unit. When these parts are working together we can call it PIR luminary. You can see simple PIR luminary and its parts on figure 1. PIR motion detector is built into the luminary and only an unobtrusive lens is visible on the outside, normally fitted in to the dome.

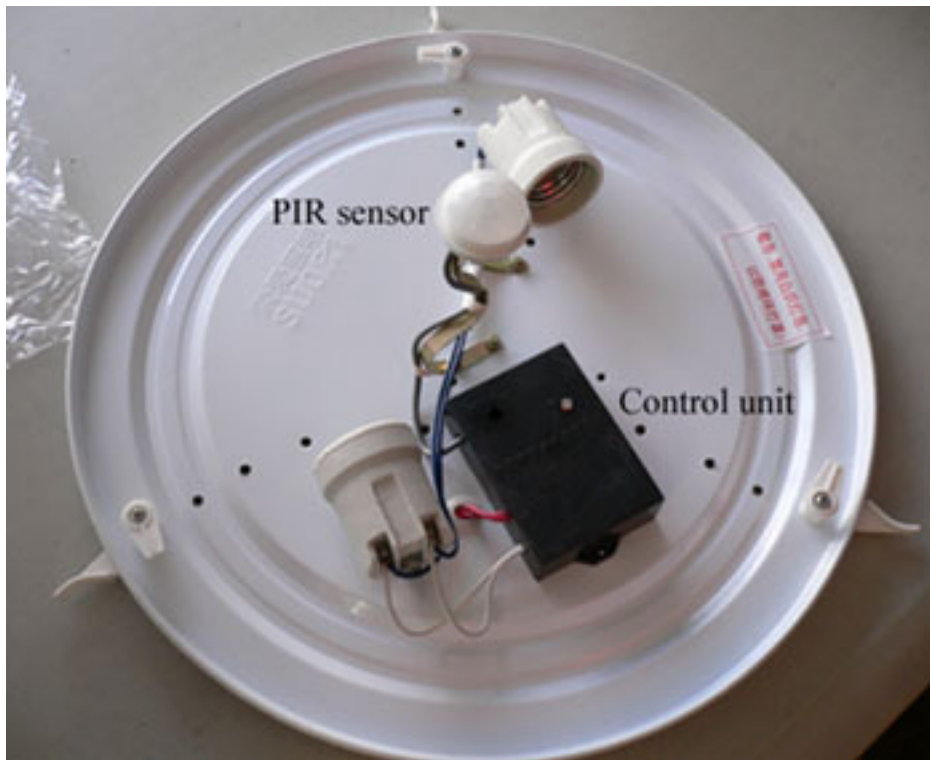


Figure 1. PIR luminary

PIR motion detector reacts to moving heat of radiation created by humans. When there is no action from the people, the lights are switched off. When PIR motion detector feels movement by people the lights are switched on.

There are many advantages for using energy saving luminaries. The most important things for using them are saving energy and saving money. PIR luminaries are also easy to install and they are user friendly. Also the risk of vandalism is appreciably reduced because there are no parts outside from luminary.

Different PIR luminaries have different kinds of properties. Advanced luminaries have many properties and they are able to set. The most common properties are 1) luminaries can be installed in chains 2) adjustable pre-set operating time 3) can be controlled using an outside twilight switch and timer 4) adjustable lux control level 5) luminaries are made for the best materials. On the figure 2 you can see Ensto PIR

luminary's control unit with adjustable pre-set operating time, adjustable lux control level and adjustable sensitivity.



Figure 2. Ensto PIR luminaire's control unit

How long time lights are switched on after sensor does not feel any movement is possible to change for a pre-set operating time, which can be adjusted. Operating time for each luminaire can be set separately according to need. For adjustable lux control level you can choose the illuminance level when lights will switch on. For example, you can set luminaire working only in the night when illuminance level is low. On figure 3 you can see PIR motion detector with adjustable pre-set operating time and adjustable lux control level. When PIR luminaires are possibility to install in chains, it gives more possibilities for the system. You can also use normal luminaires together with infrared luminaires, so it's also save money.



Figure 3. PIR motion detector with adjustable pre-set operating time and adjustable lux control level

PIR luminaries have different kinds of radiation scales depending on whether it is a roof or wall mounted luminary. Roof mounted PIR luminary has 360 degrees radiation scale and wall PIR luminary has narrower scale. On the figure 4, you can see wall PIR luminary radiation scale on the left and roof PIR luminary radiation scale on the right.

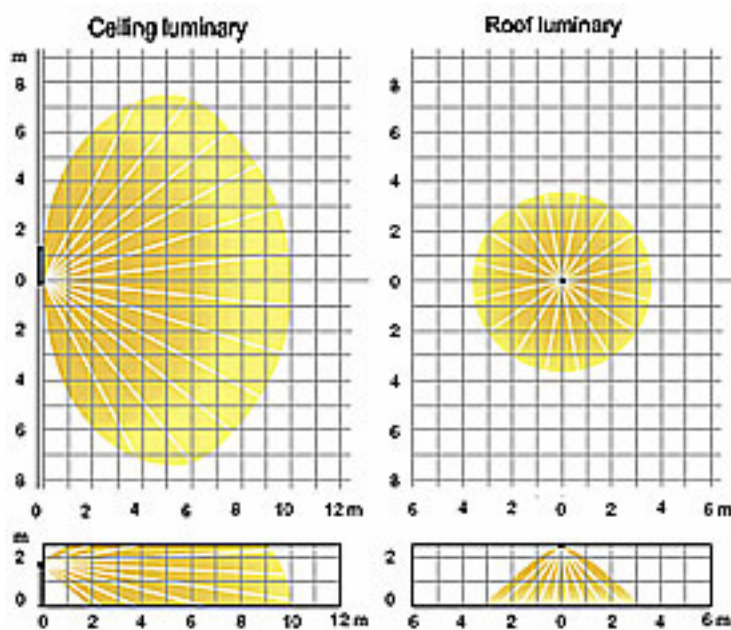


Figure 4. PIR luminary mounted on the wall and roof

2.3 Ultrasonic luminaries

Ultrasonic luminary is like a PIR luminary, but sensor is working for noise and it is normally inside luminary. Ultrasonic luminary switch on the lights when Ultrasonic sensor reacts to the noise. This type of luminaries saves energy because light is switched on a short time, which is also able to set up if luminary is well advanced. On the figure 5 you can see very common and cheap ultrasonic luminary bought from China.



Figure 5. Simple ultrasonic sensor luminary

Ultrasonic sensors emit a high frequency sound above the human and animal audibility ranges, and listen for a change in frequency of the reflected sound. Ultrasonic luminaries are able to cover larger volumes than PIR luminaries and are noticeably more sensitive but also more prone to false triggering. Air motion, due to a person passing an open doorway, or the on-off cycling of a ventilation system may trigger a poorly located or adjusted sensor. The ultrasonic sound waves cover the affected area in a continuous fashion, there are no blind spots or gaps in the coverage pattern. For this reason Ultrasonic sensors are somewhat more sensitive to movement. For example, hand motion can be detected at about 7,5 meters, arm

and body torso out to 9,0 meters and full-body motion out to over 12 meters. In narrow spaces such as corridors and warehouse aisles ultrasonic sensors detect occupants up to 30 meters.

Ultrasonic luminaries have many weak points. Lights can often switch on without any meaning and sensors are not often sensitive for normal walking. Normal Chinese ultrasonic luminaries are not sensitive enough and it is needed to make noise on your foot before lights switch on. If sensitivity of the sensor is set too high, lights can switch on without meaning from the noise coming outside or inside of the building, and many other reasons.

3. How PIR luminary works

3.1 Infrared radiation

Infrared is the part of the electromagnetic spectrum. It falls between microwaves and visible light. Its wavelength is longer than visible light but shorter than microwaves. PIR motion detector is a passive system that detects infrared energy. Passive system means it does not send any infrared radiation, only receive it. In order to make PIR motion detector that can detect a human being, it is needed to make the detector sensitive to the temperature of a human body. Humans having skin temperature of about 36,6 degrees Celsius, radiate infrared energy with a wavelength between 9 and 10 micrometers. Therefore PIR motion detectors are typically sensitive in the range of 8 to 12 micrometers. PIR motion detectors are sensitive to motion, but not by a person who is standing still, because the electronics package attached to the sensor is looking for a fairly rapid change in the amount of infrared energy it is seeing. When a person walks by, the amount of infrared energy in the field of view changes rapidly and it is easily detected.

3.2 PIR motion detector

PIR motion detector consists of Fresnel lens and Pyroelectric infrared detector. Inside the PIR motion detector has Pyroelectrical elements called Pyroelectric

infrared detector. Pyroelectric infrared detector is a thermal detector of optical radiation that utilizes the time rate of change of the spontaneous electric polarization. Pyroelectric infrared detector consists of a filter, a sensing elements and internal electronics. The filter restricts incoming radiation to a wavelength band of interest, the sensing element responds to the incident energy and produces a signal and the integral electronics assist in mating the signal with other equipment. On the figure 6 you can see a basic structure of Pyroelectric infrared detector.

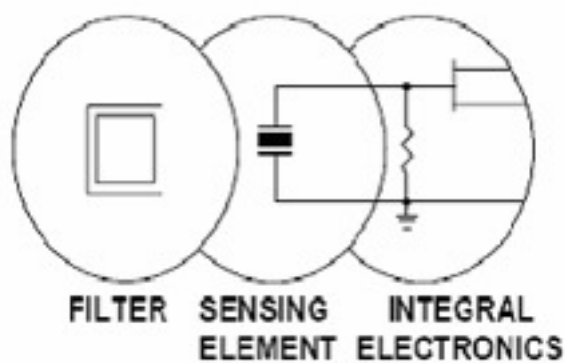


Figure 6. Pyroelectric infrared detector

Inside Pyroelectric infrared detector has a Pyroelectric sensor (sensing element) made of crystalline material. This Pyroelectric sensor generates a surface electric charge when exposed to heat in the form of infrared radiation. Pyroelectric sensor reacts to the infrared radiation caused by humans. When crystalline material face infrared radiation, state of the crystalline changes. The amount of charge in crystalline material also changes and it can be measured with FET (Field Effect Transistor). Pyroelectric sensor takes infrared radiation too wide range so it is needed limit to $8\mu\text{m}$ to $14\mu\text{m}$ range, which is most sensitive to radiation caused by human body. If the range of radiation has not limited on FET, Pyroelectric sensor would react too many things like sunlight and temperature changes. On figure 7 you can see typical configuration of Pyroelectric sensor.

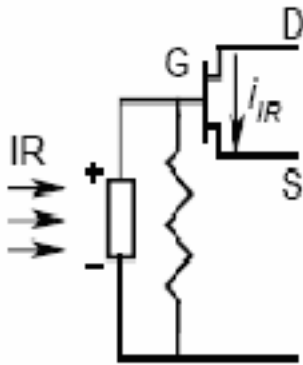


Figure 7. Typical configuration of Pyroelectric sensor

Only one Pyroelectric sensor is too sensitive to a wide range of radiation, so there is more than one Pyroelectric sensor, normally two or four. Pyroelectric sensors are connected in the way that one subtracts the other sensor element. The sensor is only working if one sensor activates from human moving and the other sensor for vibration. On the figure 8 you can see Pyroelectric infrared detector with dual element Pyroelectric sensors. This kind of arrangement cancels signals caused by sunlight, vibration and temperature changes.

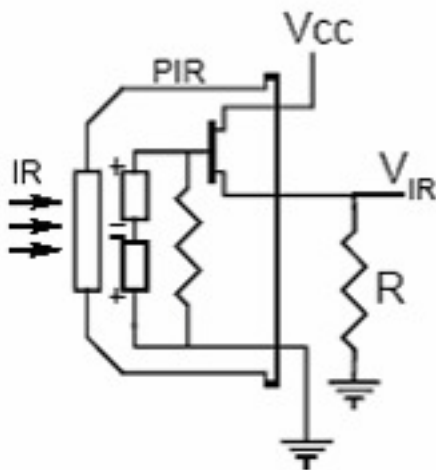


Figure 8. Dual element Pyroelectric sensor in Pyroelectric motion detector

3.3 Fresnel lens

Pyroelectric infrared detector has a lens collecting infrared radiation caused by human. Lens is sensitive for radiation sending by humans. The lens used in PIR motion detectors is called Fresnel lens. Lens is like Plano-convex conventional lens

but it is carved to thin and it has less absorption losses and small size. On the figure 9 you can see example for Plano convex lens and Fresnel lens. Fresnel lens is normally made of plastic. This material has many advantages like cheap price, easy to mount and it does not attenuate infrared signals. Plastic also have a good durability and it is not broken easily. On the figure 10 you can see how infrared radiation acts when hitting the Fresnel lens. It is very important that Fresnel lens is mounted to a focal length of PIR motion detector. Focal length should be right so infrared radiation can hit PIR motion detector in a right place.

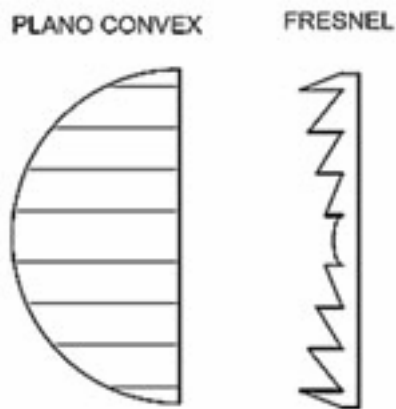


Figure 9. Plano Convex and Fresnel lens

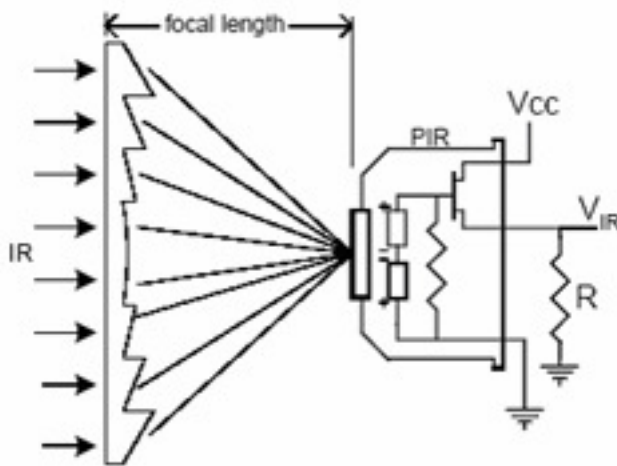


Figure 10. Pyroelectric infrared detector with Fresnel lens

4. Energy saving lighting in China

Energy saving lighting has become more and more popular in China. Mostly block of flats and public buildings have energy saving luminaries. The most common places are corridors, stairways and in front of the elevators.

The most commonly used energy saving luminary in Shenyang is Ultrasonic sensor with an incandescent lamp. That is a very simple and undeveloped way for lighting and only a source of light. That is also the most cheapest energy saving luminary and it costs only about 2€.

Visiting in a new complex of blocks of flats, there where Ultrasonic sensors with incandescent lamps on stairways and in front of the elevators. When looking around 5-15 years old block of flats in Shenyang, you can also see the same Ultrasonic luminaries in them. Ultrasonic luminary is a very simple and cheap, that is why it is so commonly used. It is also easy to install to old buildings.

Some schools and public buildings have PIR luminaries on the roof. Figure 11 has been taken from the Jianzhu University, where a lot of PIR luminaries have been used. PIR luminaries are not so widely used in China, because it is more expensive than Ultrasonic luminary. Most Chinese PIR luminaries do not have any special properties and they are not able to set. The best energy saving luminary found in Shenyang has adjustable pre-set operating time and lux control level.

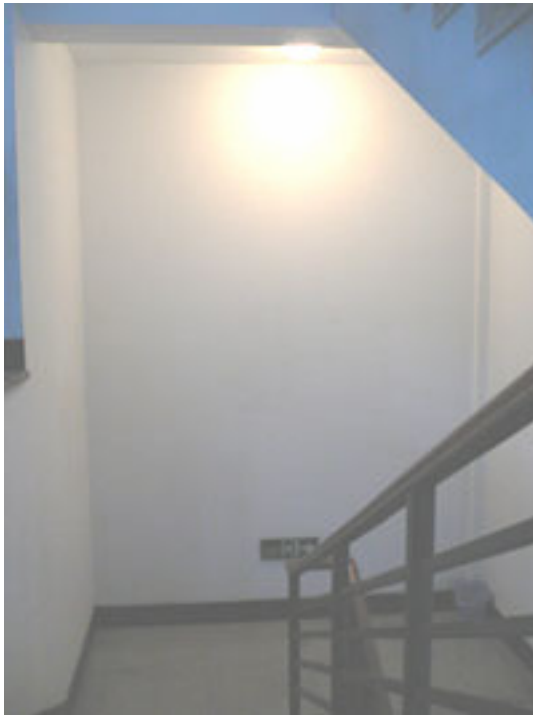


Figure 11. PIR luminary on the ceiling at Jianzhu University

5. Installing quality

In China building technology is not very high level. Also illumination is sometimes installed wrongly. Here are some examples of wrongly installed PIR luminaries in China. In first example luminary's PIR motion detector is installed on wrong direction. PIR motion detector should have been installed that it can "see" better and it is directed to the way where people come to close it. Now motion detector is in the side of wall where is no movement by the people. This situation is easy to see from figure 12. If the PIR motion detector would be installed to another side, it can "see" both stairways correctly. Luminary's motion detector is not able to detect people correctly because sensor is installed in the wrong place. When closing luminary it just switch on when you are very close or under to it. It also can be a sign for bad sensitivity. Installing and placing PIR luminary is very important thing that it is working correctly.



Figure 12. PIR motion detector installed wrongly

Second example is installing many PIR luminaries after another in corridors. This installation is easy to make only using couple of PIR luminaries and switch them in the chain with normal luminaries. This type of luminary doesn't have possibility to switch them in to the chain. Switching PIR luminaries and normal luminaries in chain, is a good way to save money and it makes a better solution. This situation is described on figure 13.

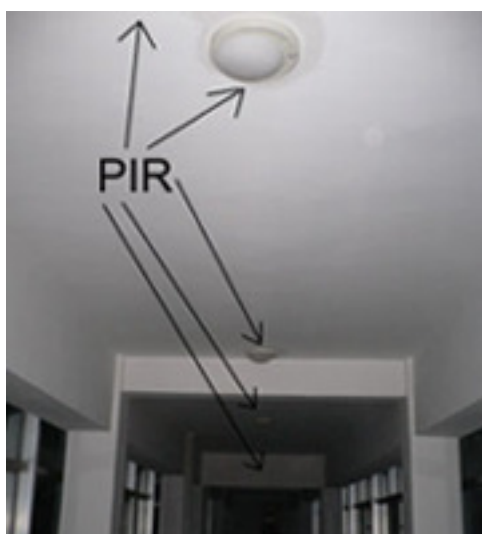


Figure 13. PIR luminaries without chains

6. PIR luminary versus Ultrasonic luminary

These two luminaries are used in energy saving luminaries. PIR luminaries work for infrared radiation caused by human and Ultrasonic luminary for Ultrasonic noise radiation. Ultrasonic sensor luminary can switch the lights on without seeing the object. PIR sensor luminary can't see around corners and a person will not be detected if there is an obstruction, such as a partition, between the person and the detector. PIR luminaries are not so sensitive for errors like Ultrasonic luminaries. Ultrasonic luminaries are much more cheaper than PIR luminaries, because the price of the components are lower in China.

7. Measurements

7.1 Information of tested PIR luminary

Manufacturer:	Kengo
Model:	RC240B
Description:	PIR Sensor Ceiling Light
Specification:	Voltage: 120V, 230V Wattage: Max. 40W x 2 Lamp Base: E27 Lamp Type: Candle/G45 bulb, compact fluorescent lamps Construction: Metal and Glass Conforms to EN 60730, 60598-2-1
Optional Features:	<ol style="list-style-type: none">1) 360 degree detection angle2) Suitable for install at door entrance, staircase and exits3) Opal glass diffuser4) Easy installation

Standard:	Completed to UL and CE standard
Other:	Detection coverage: 360 degrees and maximum radius 5 meters
	Maximum length: 410 mm
	Maximum height: 120 mm
	Maximum width: 410 mm
	Not suitable to use dimmers
	Duration time: from 10 ± 5 seconds to 4 ± 1 minutes adjustable
	Lux control level: from daylight to night adjustable
	Indoor use only
	Price 20€

7.2 Kengo PIR luminary in round and sector walk testing

Round and sector walking tests idea is got the drawing for PIR motion detector working area. The test shows what is a sensitivity of motion detector and which places luminary switch on. On the picture 14 you can see measuring surrounding.

First test was made by walking along the sectors and put mark on the floor where light switch on (90° to -90°). Second test was made walking towards to luminary in different angles (6m to 1m). These two ways of walking differs where PIR motion detector “see” human. When walking along sectors the signal is much more higher than walking towards to luminary. You can see the difference of signal powers on figure 15. The infrared radiation beams are also the different lengths because the shape of Fresnel lens. The light of the room, material of the basement and room temperature can cause some errors to the measurements. Table 1 shows the results of the measurement.



Figure 14. Measuring surround of round and sector walk testing

Table 1. Kengo PIR luminary round and sector walking testing

Measurement 1: Round walking

Degrees	Distance (m)
90	
80	4,0
70	3,0
60	4,0
50	3,0
40	2,5
30	4,5
20	1,0
10	4,0
0	5,5
-10	2,5
-20	1,5
-30	5,5
-40	2,0
-50	5,0
-60	6,0
-70	3,0
-80	4,5
-90	5,0

Measurement 2: Sector walking

Degrees	Distance (m)
90	0,0
80	1,0
70	1,5
60	0,5
50	0,8
40	2,0
30	0,0
20	0,0
10	2,0
0	1,0
-10	1,0
-20	1,5
-30	1,0
-40	0,0
-50	0,0
-60	2,0
-70	0,5
-80	2,0
-90	0,0

From the figure 15 is easy to describe how PIR motion detector works. Inner line figures where PIR motion detector detects humans motion when walking towards to luminary. When walking towards to luminary, lights switch on near or just under luminary. It means that sensitively is set too low so PIR motion detector is not sensitive. Good PIR luminary have a better sensitively and it is also able to set up. Outer line figures where PIR motion detector detects humans motion when walking around the sectors.

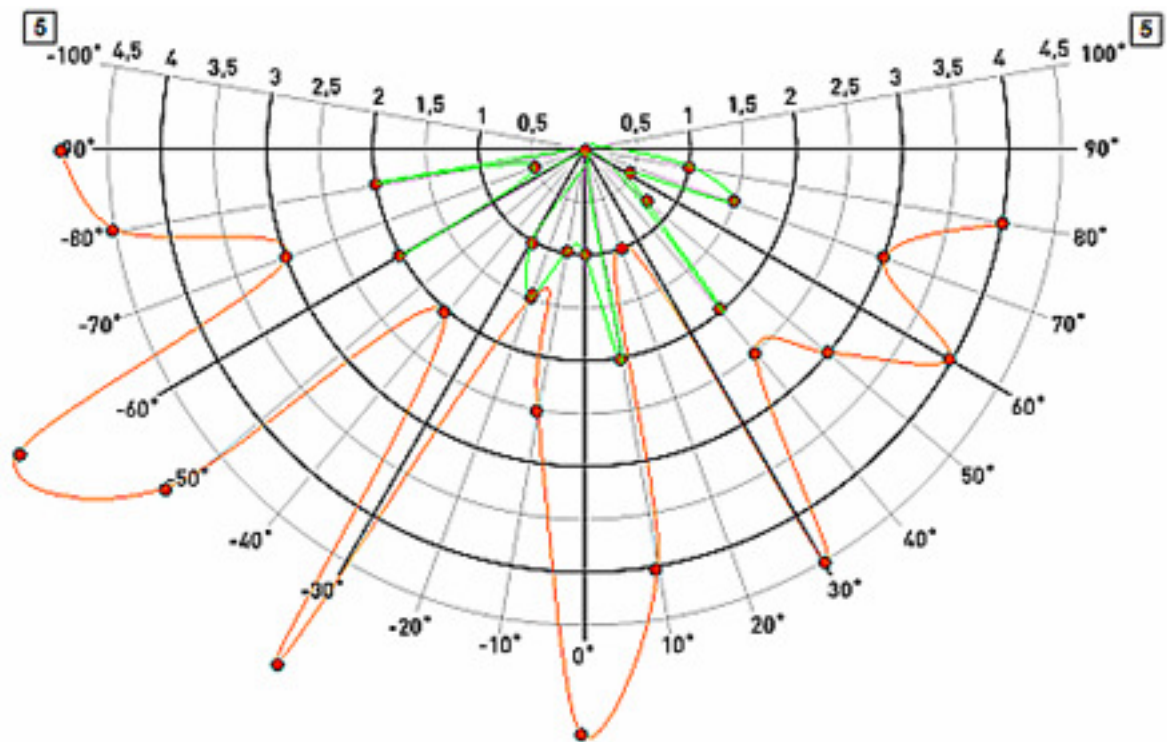


Figure 15. How PIR motion detector reacts moving in different ways

For example on the figure 16 you can see how good PIR luminary should work in minimum and maximum sensitively when sensitively is able to set up. Maximum sensitively reacts more far and it is working well. But if sensitively is set up too high, luminary is sensitive for errors like switching on without reasons. Usually these errors are caused by ventilation, heating systems, sunlight and reflective materials.

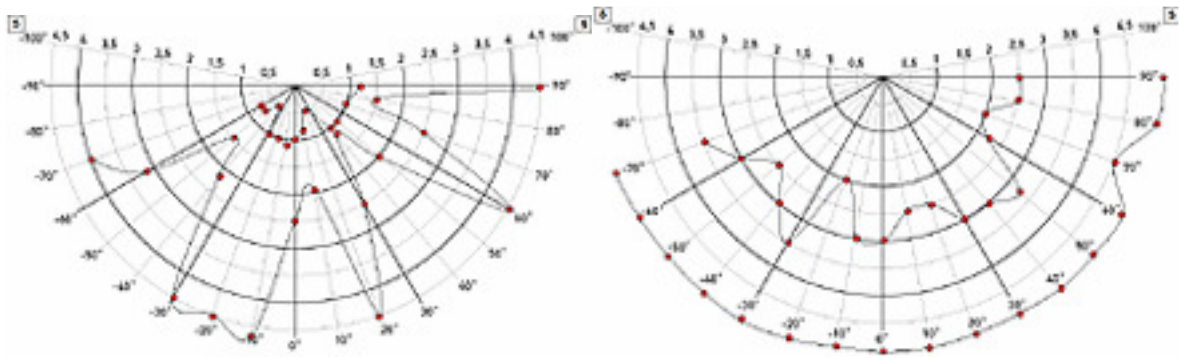


Figure 16. Same PIR luminary set for different sensitivities, minimum and maximum

7.3 Kengo PIR luminary time potentiometer test

Kengo PIR luminary time potentiometer was tested by using stop-watch. This test shows is luminary's time potentiometer working correctly. Kengo PIR luminary has adjustable time range and it is carried out using potentiometer. Manufacturer proofs time range to be from 10 ± 5 seconds to 4 ± 1 minutes. On the table 2 you can see measured times using stop-watch.

Table 2. Time potentiometer test

TIME potentiometer test

SET	Measured Time	Manufacturer Time
MIN	7,0 s	10 ± 5 s
HALF	1 min 35 s	
MAX	4 min	4 ± 1 min

The result of the measurement: measured times are inside the based value ranges what is written on the manufacturer manuals.

8. Closer looking for Kengo PIR luminary

The closer looking inside luminary gets a possibility to compare price and quality of components. The most important parts in PIR luminary are relay, Pyroelectric infrared detector, microcontroller and lens.

Relay need to lasts many on/off switches without broken. Relay is the most important part for durability. Different relays have big quality changes and some relays lasts long time without broken. Kengo PIR luminary have unknown relay

which type is CR730-A-24. This relay does not have any information find on internet, so the price is difficult to estimate. This relay tolerate only 7,5 A current and it is too less. Normally 16 A relay is used because when incandescent lamp switches on, it takes a big current peak, because cold wolfram's resistance is very high. The current peak needs relay to last 16 A, so 7,5 A relay is not enough. Relay with 7,5 A can easily broken, because it don't tolerate enough current. On the figure 17 you can see electronics inside the motion detector. The quality of circuit board seems to be good, and the quality of junctions is good. Kengo luminary has been made quite well, but it is not working well. Also the body of the luminary is strong and it is easy to install.



Figure 17. Electronics inside PIR motion detector

Kengo luminary and also other PIR luminaries found from Shenyang don't have ballasts. Ballasts have fitted in to the lamps so it is not needed in luminaries.

Luminaries without ballast seems to be the most common way in China. Lamp with ballast is cheap in China so the price of the luminary is got down without using ballasts in luminaries.

9. Comparing luminaries, Kengo and Liang Mei

This project has also another PIR luminary, but this luminary has not been made any measurements. Manufacturer is Liang Mei and PIR luminary has only been tested that it works. Both PIR luminaries are on the figure 18.

Manufacturer:	Liang Mei
Model:	GD-106-E
Specification:	Voltage AC 220 \pm 20 V Frequency: 50-60 Hz Wattage Max: 25W x 2
Other:	Maximum radius 6 meters Sensor works about 20000 on off switches Plastic dome Price 7€



Figure 18. Kengo and Liang Mei PIR luminaries

Two PIR luminaries Kengo and Liang Mei have been looking closer and find out the properties they have. Kengo PIR luminary price is 20 € and it is the expensive one founded from Shenyang. This PIR luminary has some setting possibilities like

adjustable duration time and lux control level. Liang Mei PIR luminary don't have any possibilities to set up and the price is only 7,0 €. Liang Mei PIR luminary doesn't have relay and manufacturer gives lifetime for 20000 on off switches. Kengo PIR luminary body is well done but Liang Mei has a floppy body. Kengo has a glass dome and Liang Mei has a plastic dome. All around quality of Kengo PIR luminary is better than Liang Mei's, but the price is three times more expensive. The price of the product is the most important thing for Chinese people. It is supposed that quality in China will come more important in the future, but now the price of the product is only interesting thing. This time Chinese designer would choose Liang Mei PIR luminaries to their buildings, because price is three times cheaper than Kengo's PIR luminary.

10. Illumination standards in China

China is a difficult country in legally. It is very difficult to say what is right and what is wrong. Talking with many peoples, nobody is caring about standards. Everybody says that regulations and standards are not important and nobody is caring about them. On the next chapters are Chinese illumination regulations from civil architecture designing book. This book has Chinese illumination standards and regulation. This book is used all over the China, and it should be the only source of real information.

10.1 Normal illumination standards and regulations in China

1. Civil architecture illumination standard is divided in to these grades:
0,5lx, 1lx, 2lx, 3lx, 5lx, 10lx, 15lx, 20lx, 30lx, 50lx, 100lx, 150lx, 200lx, 500lx, 750lx, 1000lx and 2000lx.
2. Illumination standard level means the average value for illuminance on the working space.
3. According to the different kind of activity or work, illumination standard levels are set to the three different grades: high, middle, and low. Designer should choose the right value for illumination according to the need. Every illumination values are

acceptable, but middle is the most commonly used. On the table 3 you can see illumination standard levels in commercial buildings. On the table 4 are illumination standard levels in civil houses. On the table 5 have illumination levels in public buildings.

Table 3. Commercial building illumination level standards

Space	Measurement plane	Illumination standard level (lx)		
		Low	Middle	High
Warehouse	0.75m	30	50	75

Table 4. Civil house illumination level standards

Space	Measurement plane	Illumination standard level (lx)		
		Low	Middle	High
Stairway	Floor	5	10	15
Toilet	0.75m	10	15	20

Table 5. Public building illumination level standards

Space	Measurement plane	Illumination standard level (lx)		
		Low	Middle	High
Aisle	Floor	15	20	30
Stairway	Floor	20	30	50
Washroom	0.75m	20	30	50
In front of the Elevator	Floor	30	50	75
Bathroom	Floor	20	30	50

4. Dust and pollution cause attenuation for illuminance level. When designing lighting, the correction coefficient is needed to take into consideration for dividing illuminance value for correction coefficient. You can see on table 3 the correction coefficients for illuminance levels in different places.

Table 4. Correction coefficient for illuminance levels

Environment pollution character	Work or live space	Correction coefficient for illuminance level	
		Filament lamp, fluorescent lamp, gas lamp	Halogen lamp
Clean	Bed room, office, dining-room, reading room, drawing room	0.75	0.8
Normal	Shop, waiting room, show place	0.70	0.75
Dusted	Kitchen	0.65	0.70

10.2 Emergency illumination

Evacuate illumination level should be more than 0.5lx measured from the floor. Evacuate illumination is used for emergency situations example fire and earthquake situations.

Exit places need to have Exit sign leading people out of building.

11. Marketing research

11.1 Marketing research information

Idea of making marketing research is get more information about markets and know what people needs and wants. This marketing research took part four people from Shenyang. All of them are working close with luminaries and they right people to answer for several questions. Some of them were working in Designing institutes and some of them working in Jianzhu University.

This marketing research only gives direction, because there were not so many people who answered. It is very hard to find right people to answer these questions and many of them wants money for it. Marketing research focused on important questions what Ensto wanted to know.

The purpose of this marketing research is to give conclusions to Ensto. Company is planning to direct their PIR luminary products to Chinese markets. It is important to know what Chinese people think about energy saving luminaries and are they satisfied for energy saving luminaries in China.

11.2 Answers of respondents

Question one. First question of this marketing research was: what is the most common used energy saving luminary in China. All respondents said that the most common energy saving luminary is Ultrasonic luminary which is working for noise.

Question two. In second question wanted to know what is the most common lighting control system in China. Answers were not correct because respondents did not know any lighting control systems. Conclusion is that lighting control systems are not common in China and very rarely used. All the PIR luminaries and Ultrasonic luminaries are independent and they are not switched to lighting control systems.

Question three. Third question of this marketing research was: what are the most important properties in luminaries and lighting control systems. As expected lighting control system did not get any answers and also answers for luminaries were not good. One person said that infrared rays are important for PIR luminaries.

Question four. Fourth question was about advantages and disadvantages for energy saving luminaries in China. This question got good answers and all the respondents told their thinking for advantages and disadvantages. All the respondents told that cheap price of luminaries is the best advantage. Question of disadvantages got many different answers. First respondent said that luminaries are not standardized so they do not have any common standards. Second respondent answered that luminaries have short service life and they easily broken for a short use of time. Other respondents also told that luminaries are easy to broken and there is no many different models for luminaries. There has only one common type of luminaries without any possibilities to set up.

Question 5. On the fifth question asked about estimated lifetime for Chinese energy saving luminaries. First respondent told that life time for luminaries is approximately five to six years, second respondent said about 3 years, third respondent said about fifteen to fifty months and the last one told that life time is about two to six years. It is easy to say that Chinese energy saving luminaries are easy to broken and do not carry long life time. It can be estimated that common Chinese energy saving have about 3,5 year service life based on these answers.

Question six. On the sixth question had three parts and respondent should fill X to the part they are think is closest for the question. All of the three questions had the same alternatives: satisfied, good, satisfied, poor and useless.

First question asked the quality of Chinese energysaving luminaries. On the figure 19 you can see answers. Respondents were satisfied for the quality for energysaving luminaries. Chinese people do not think too much quality if price is cheap.

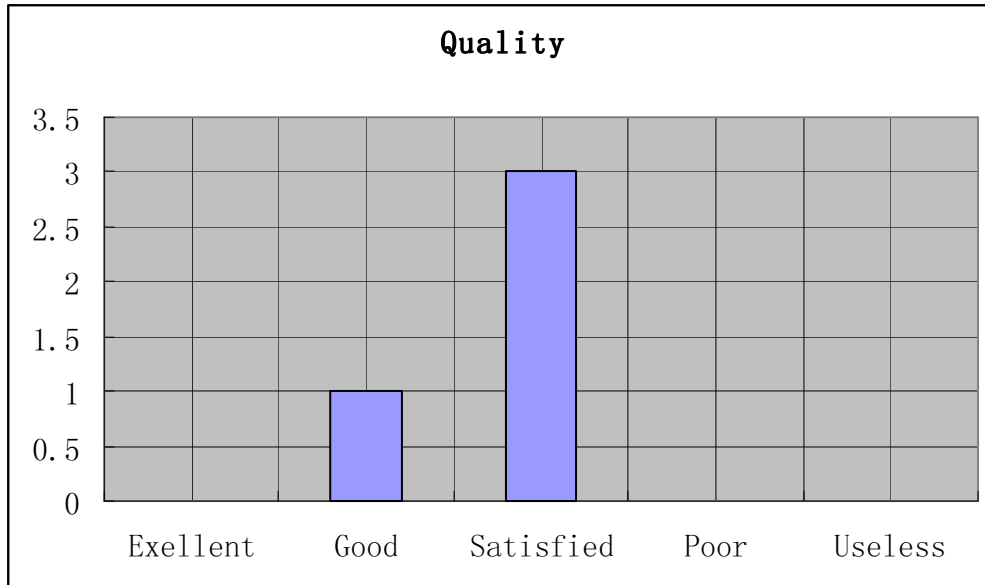


Figure 19. Quality of energy saving luminaries in China

Second question asked availability of energy saving luminaries in China. This question got many answers differing from each others. All answers for availability were good to poor. Respondents were quite satisfied for availability of energy saving luminaries in China. On the figure 20 you can see what respondents thought about availability in China.

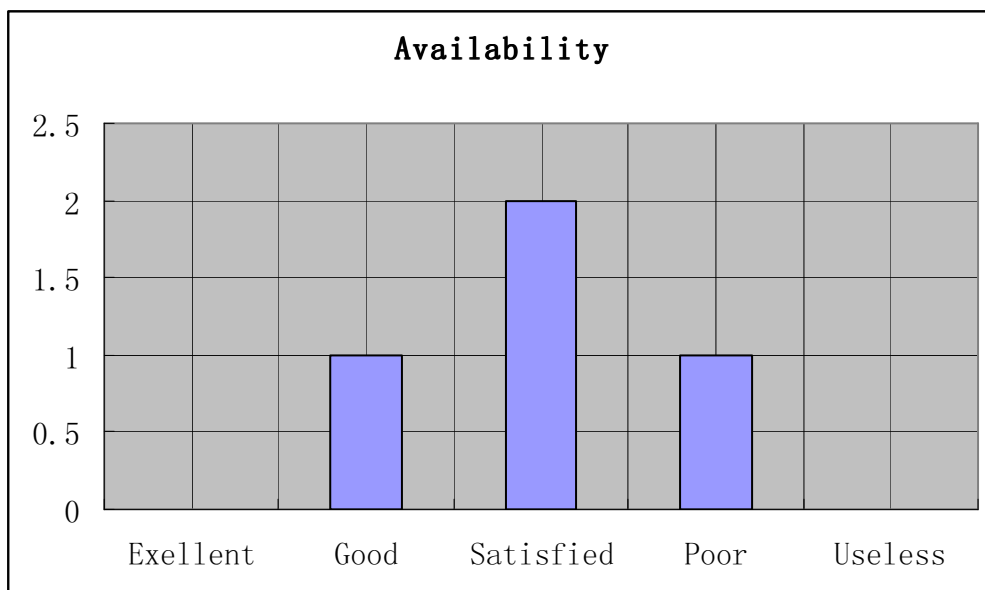


Figure 20. Availability of energy saving luminaries in China

Third question wanted to know is respondents satisfied for manufactures warranty and after services. All the respondents were totally unsatisfied for manufacturers warranty and after service. On the figure 21 you can see what respondents answered to this question. One respondent told warranty and after service what manufacturer gives is totally useless, the other three respondents answered that manufacturers warranty and after service are in poor level. The conclusion is that many manufacturers do not give any warranty to their products and if they give something, it is not working.

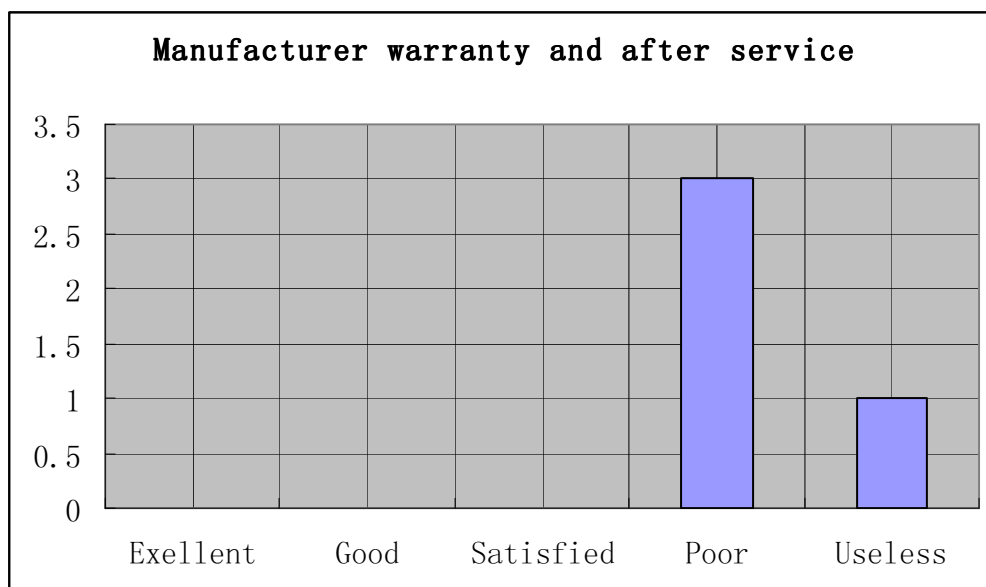


Figure 21. The state of manufacturers warranty and after service in China

Question seven. On the question seven of this marketion research had a question of which are the most important things when buying energy saving illumination products from China. The alternatives were quality, price, warranty, availability, looks and after service.

The first respondent said that Availability and looks are the most important things. Second important thing was price and third important things were Quality and after service. Respondent thought that manufacturers warranty is not important. On the figure 22 you can see the answers of first respondent.

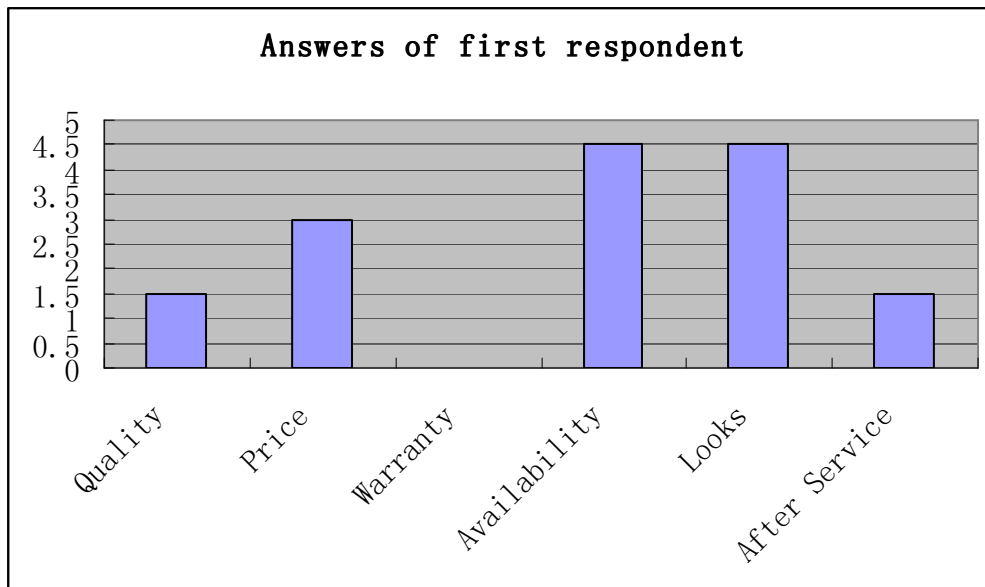


Figure 22. Answers of first respondent to question seven

Second respondent that availability is the most important thing when buying energy saving illumination products. He also mentioned that price of the products is important. Third important things for respondent two was quality of illumination products. Two of the most not so important things were after service and looks of the products. As respondent one, also respondent two did not gave any special On the figure 23 you can see the answers of the second respondent.

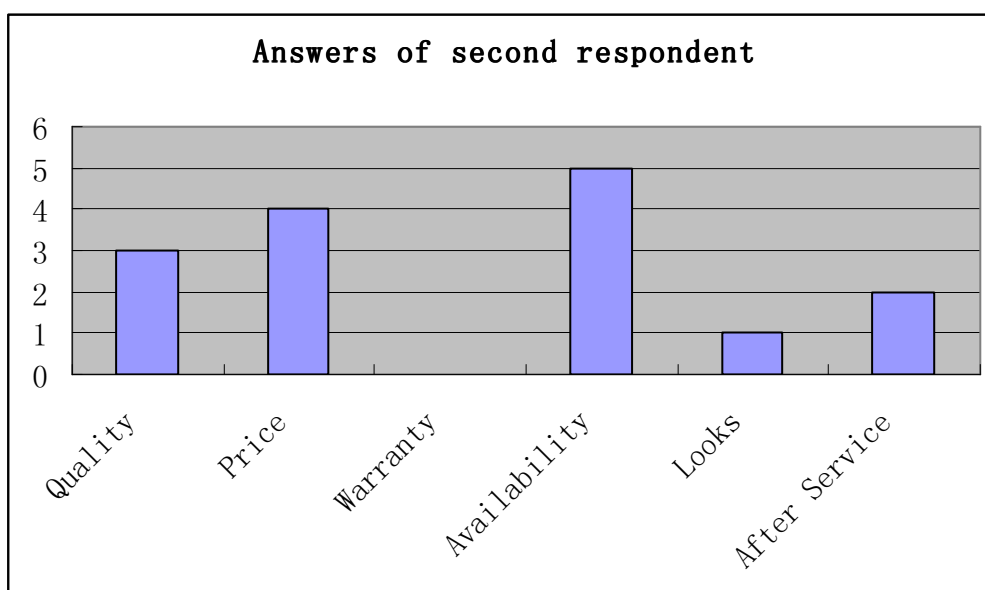


Figure 23. Answers of second respondent to question seven

Third respondent answered that price of the illumination product is the most important things. Second important thing was availability and third came quality. Products looks and after service were not important for respondent. He said that warranty is not important thing when buying illumination products. On the figure 24 you can see the results this question.

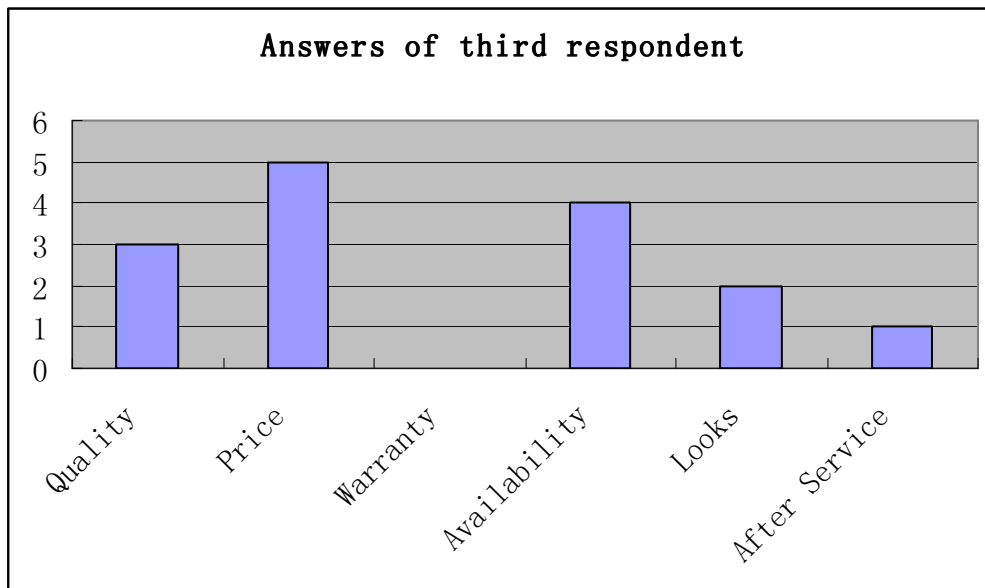


Figure 24. Answers of third respondent to question seven

Fourth and the last respondent gave only three important things. Availability was the most important thing for him. Also the price of products and quality was important for him. On the figure 25 you can see answer of the fourth respondent.

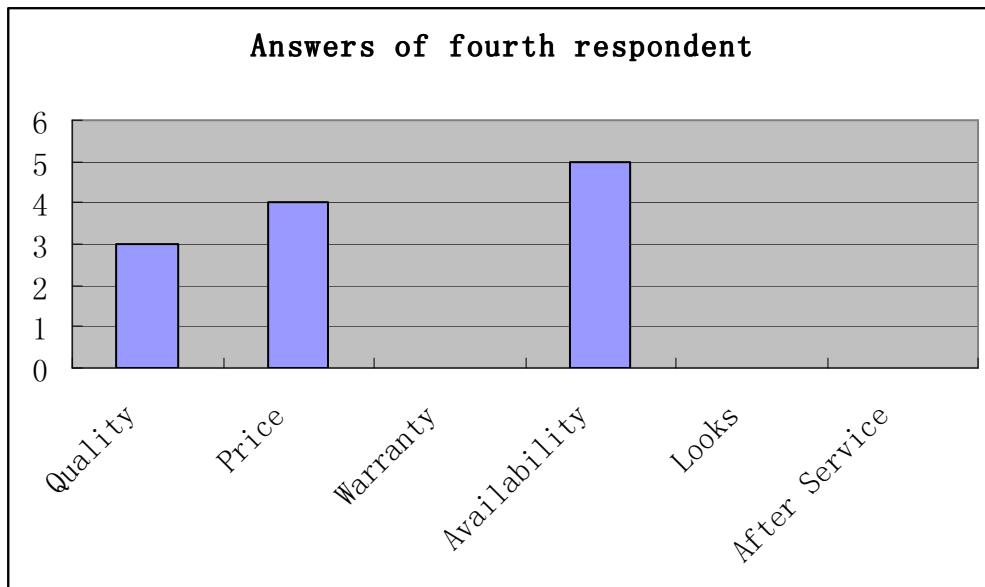


Figure 25. Answers of fourth respondent to question seven

Question eight. Eight question of this marketing research was getting information for price level of energy saving luminaries in China. Respondents were asked to list both, PIR luminaries and Ultrasonic luminaries price level. Respondents told that estimate price for PIR luminaries in China is 100 RMB per PIR luminary. Estimate price what respondents gave to Ultrasonic luminaries was 10-20 RMB per Ultrasonic luminary. Common Ultrasonic luminaries in China is only sound control, base and incandescent lamp. This combination is hard to call Ultrasonic luminary, because it is only a primitive source of light.

Question nine. Second last question number nine try to find out are the respondents ready to pay more for high quality illumination products if quality, afterservice , looks, durability etc. is good. Only one respondent told that he is ready to pay double price if he gets high quality illumination products. The other three respondents said that they need to think it and answer is maybe.

Question ten. The last question ten wanted to find out is respondents have any free comments or wishes for the future and which things they hope are better in the future in China. First respondent told that energy saving luminaries will come more and more popular in China. He also answered that price of the electricity will raise

so using energysaving luminaries is important. Second respondent hope more cheap prices and luminaries can be used in many places. Third respondent said that life time of the luminaries is short and he hope to get better quality so luminaries can have longer service life. He also hope that there could be more different types of energysaving luminaries.

11.3 Summary of marketing research

The result of marketing research was quite expected. The lack of respondents makes this marketing research a little suspicious because there has only four respondents telling their opinions. The marketing research can be good if more professional people can take part of it.

Respondents were not satisfied for manufacturers warranty and after service and keep it very poor level. Most of the respondents were satisfied for availability of energy saving luminaries but thought that luminaries don't have possibilities to use in wide range.

12. Conclusions to Ensto

Based on this thesis, Ensto have possibilities to direct their energy saving illumination products to China markets. Biggest problem in China has overall cheap prices. For Chinese people the price is very important thing when they buy something. In these days quality is not seem to be important thing for customers, which can be a problem. The most common thinking is: "if we can have a cheap price, we win money"! But this kind of attitude will lose money, not save.

The conclusion to Ensto would be that they should find high technology building solutions and direct their energy saving illumination products to these buildings. Normal people who build block of flats don't want to pay more than 2€ for energy saving luminary, and for 2€ they can have common Ultrasonic luminary in China. China is a huge country full of different kinds of building areas. The most modern cities like Shanghai would be right surrounding for Ensto illumination products.

*Thanks to taking part of this project,***FINLAND****Ensto Oy**

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Sources

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Phones and emails with Taavi Kallankari

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